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Hanussek et al.

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- (54) **HANDHELD WORK APPARATUS**
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- (*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 396 days.

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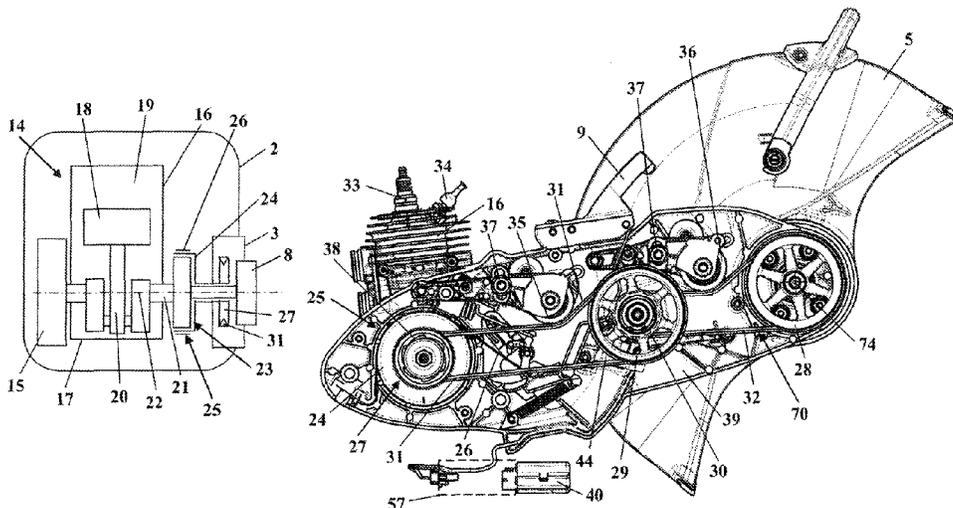
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(57) **ABSTRACT**

A handheld work apparatus has a drive motor which drives a work tool rotationally via a belt drive. The belt drive has a first, driving pulley and a second, driven pulley. The second pulley is connected fixedly to the work tool so as to rotate therewith. The rotational speed of the second pulley is lower during operation than that of the first pulley. A brake unit acts on the belt drive. A first drive belt of a first stage and a second drive belt of a second stage act between the pulleys to transfer the drive torque. The belts each bring about a rotational speed reduction. The belt drive includes a redirection roll which bears against the belt, via which the highest drive torque is transmitted during operation. As a result, a braking operation of the work tool is enabled independently of the rotational speed of the tool.

26 Claims, 7 Drawing Sheets



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Fig. 1

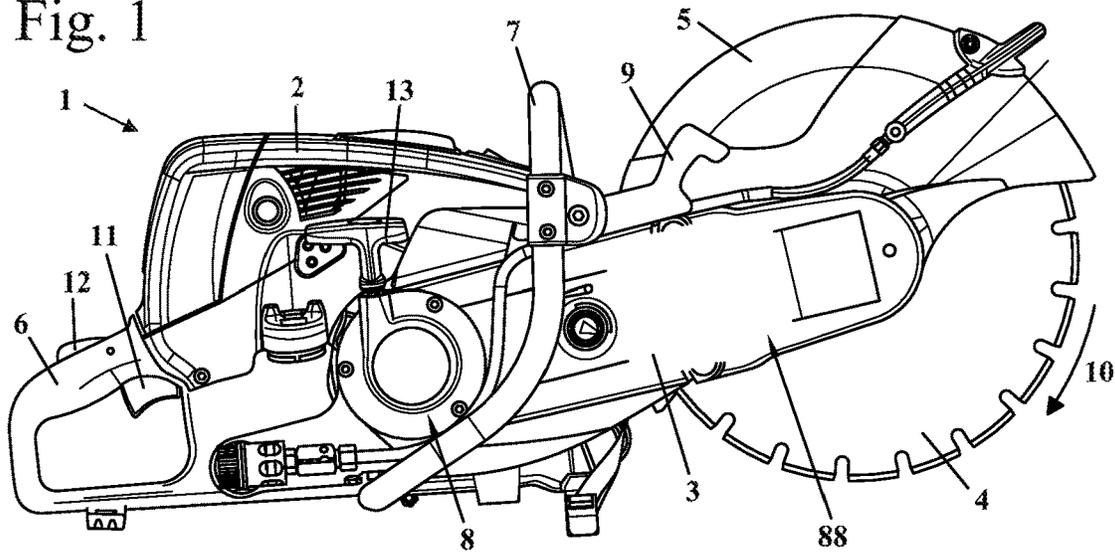


Fig. 2

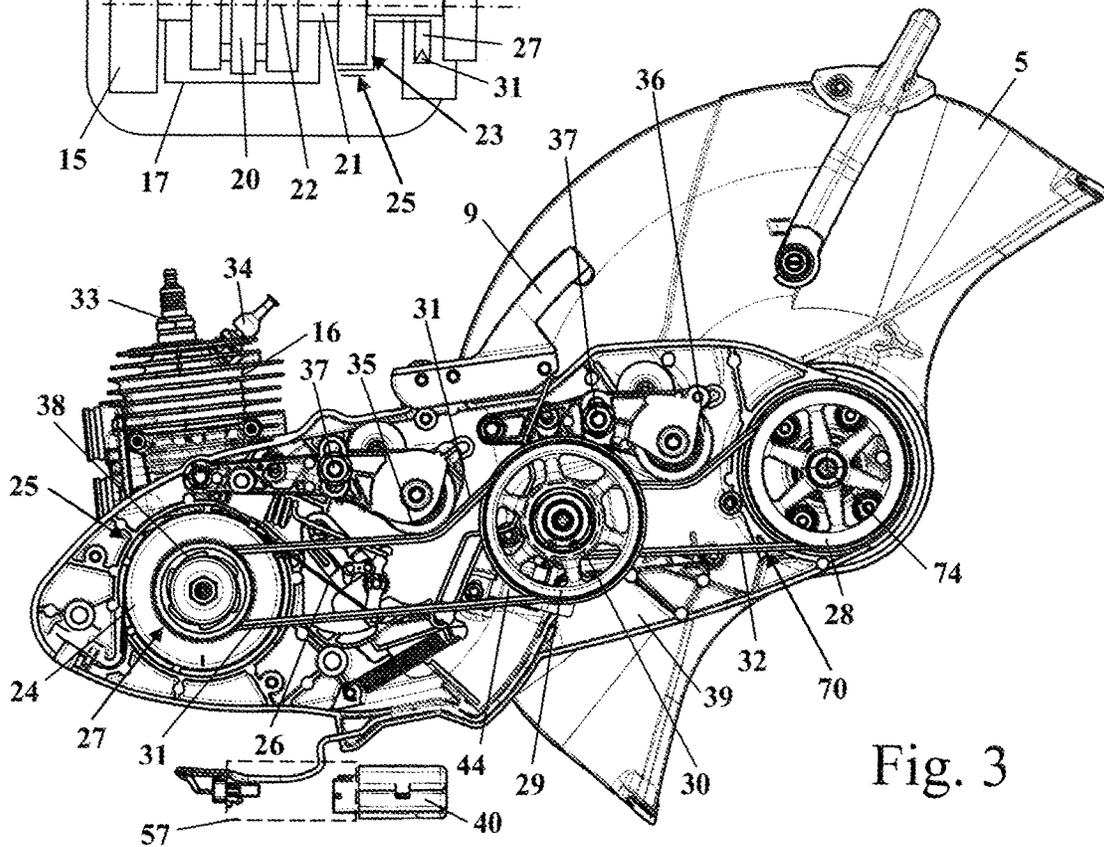
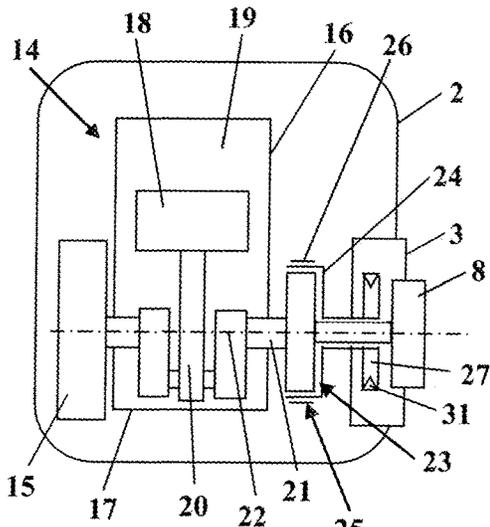


Fig. 3

Fig. 4

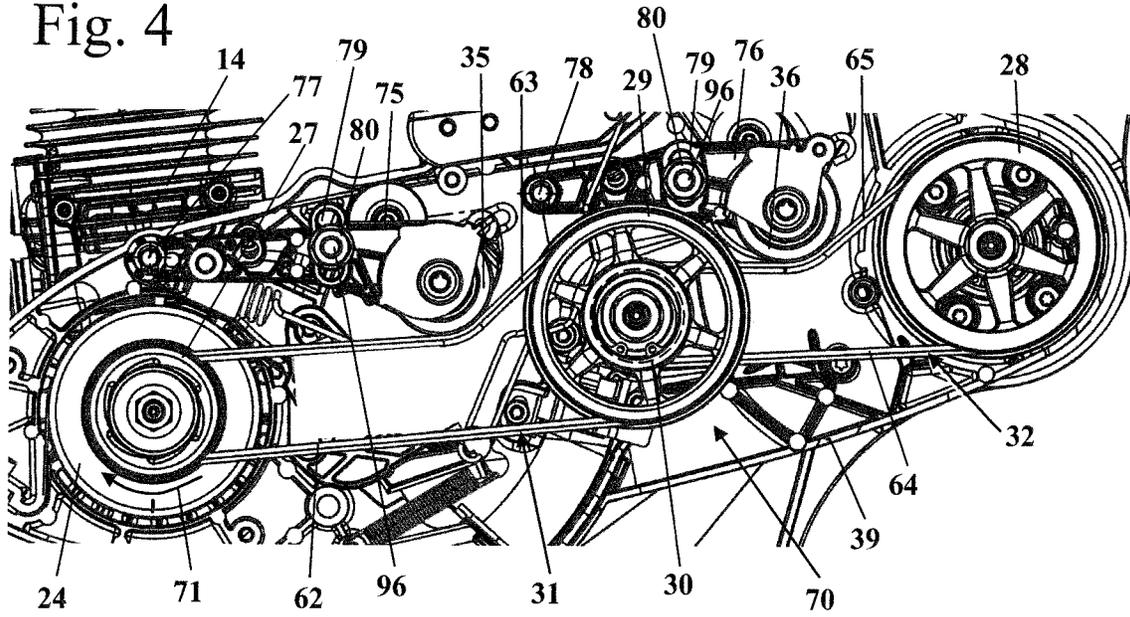


Fig. 5

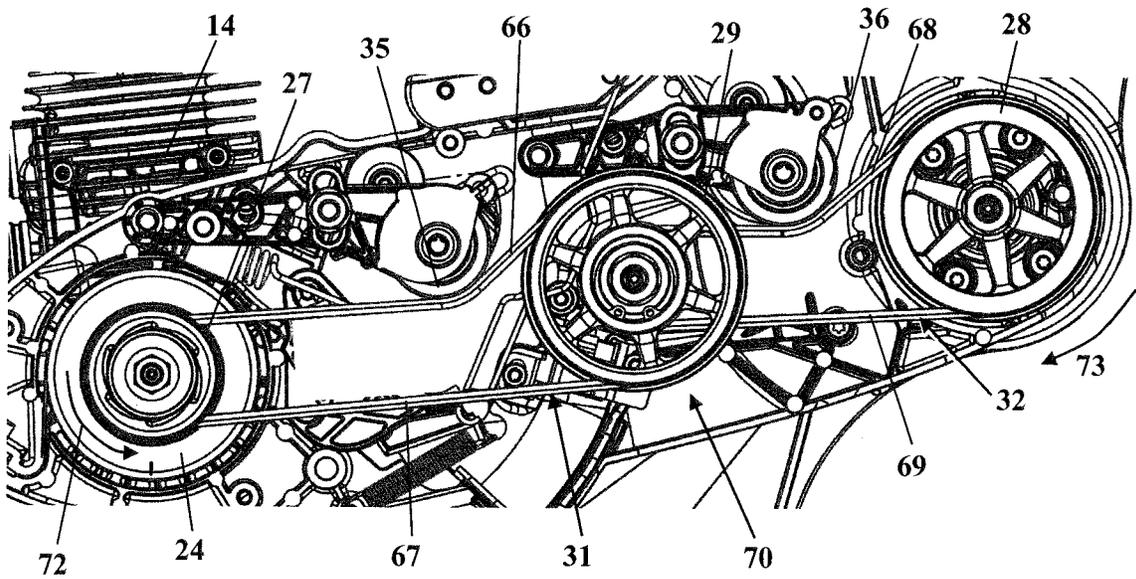


Fig. 6

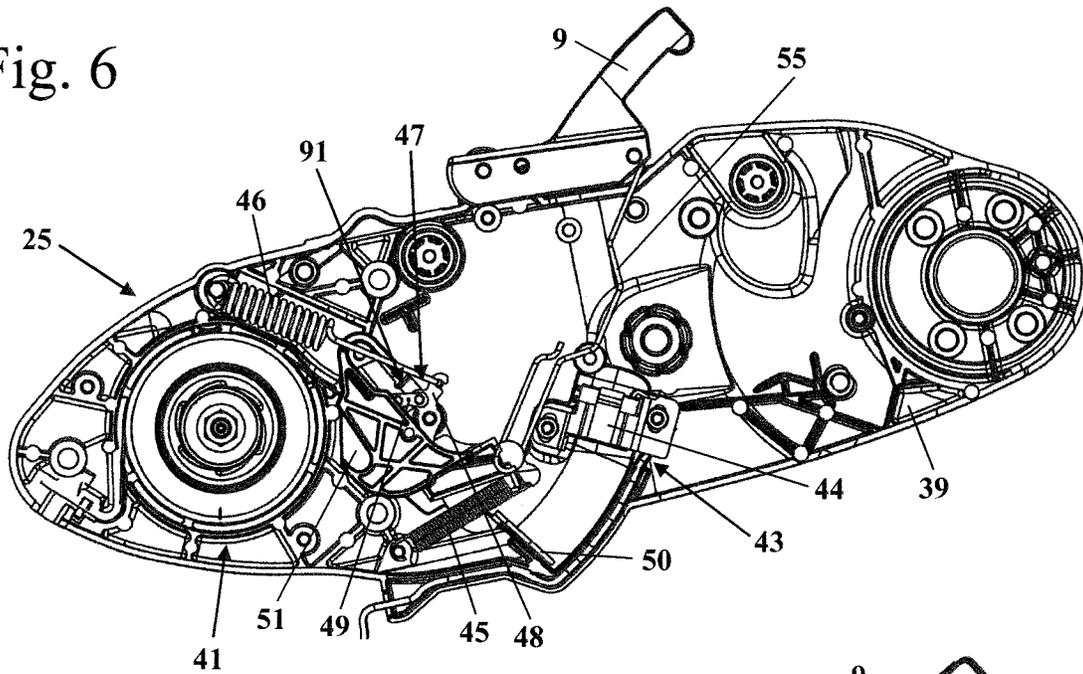


Fig. 7

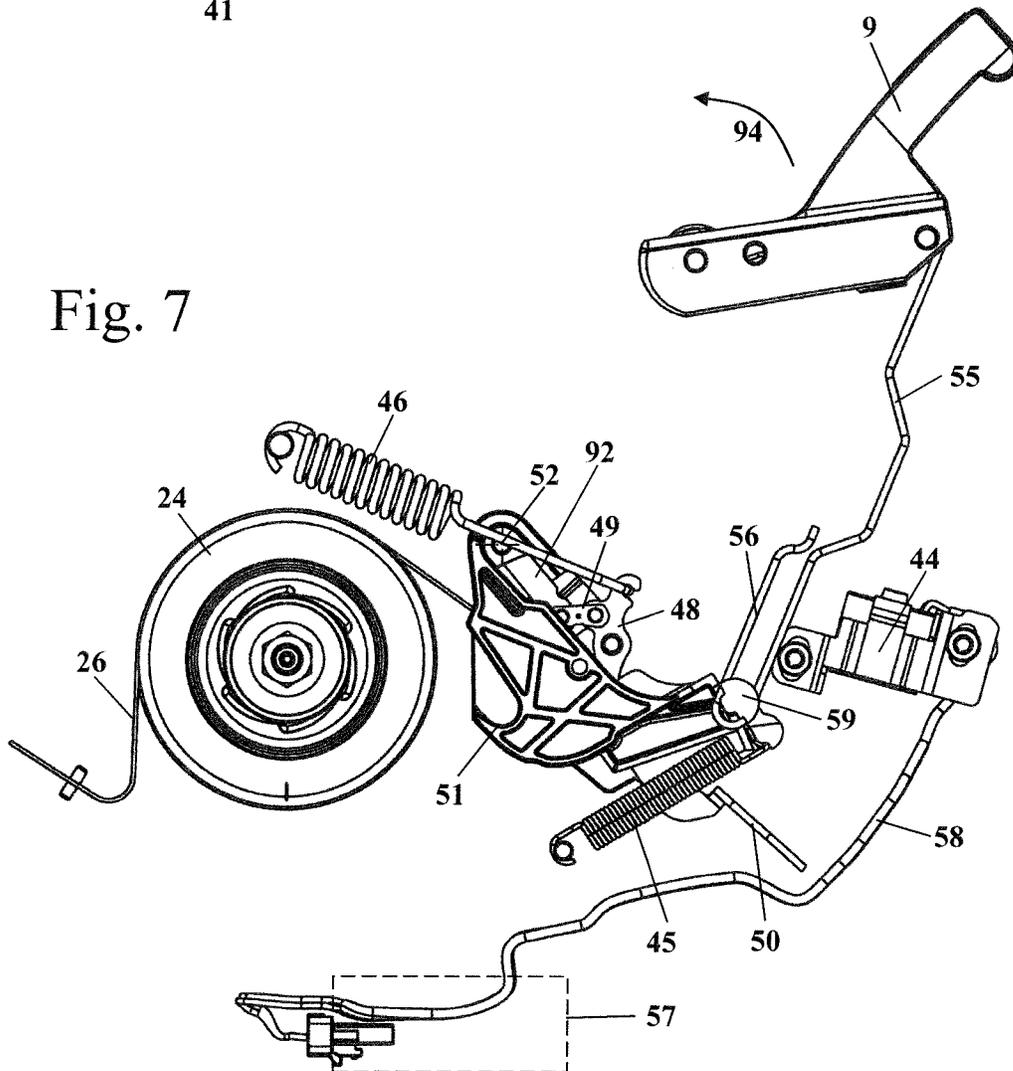


Fig. 8

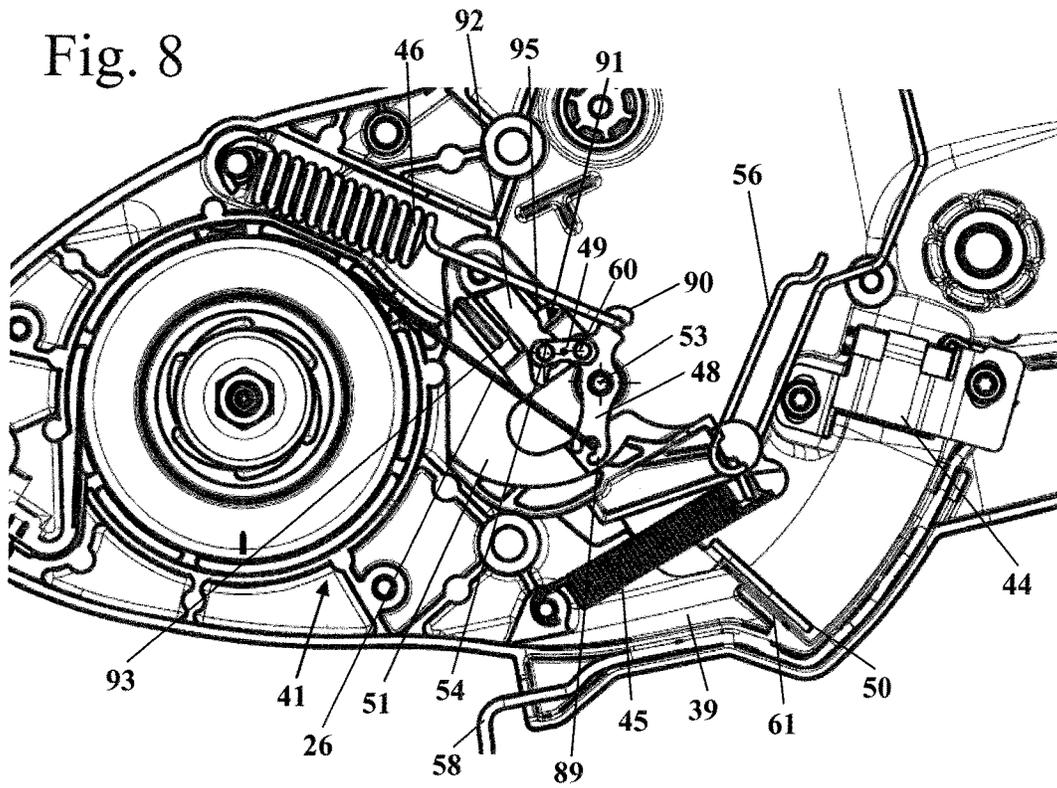


Fig. 9

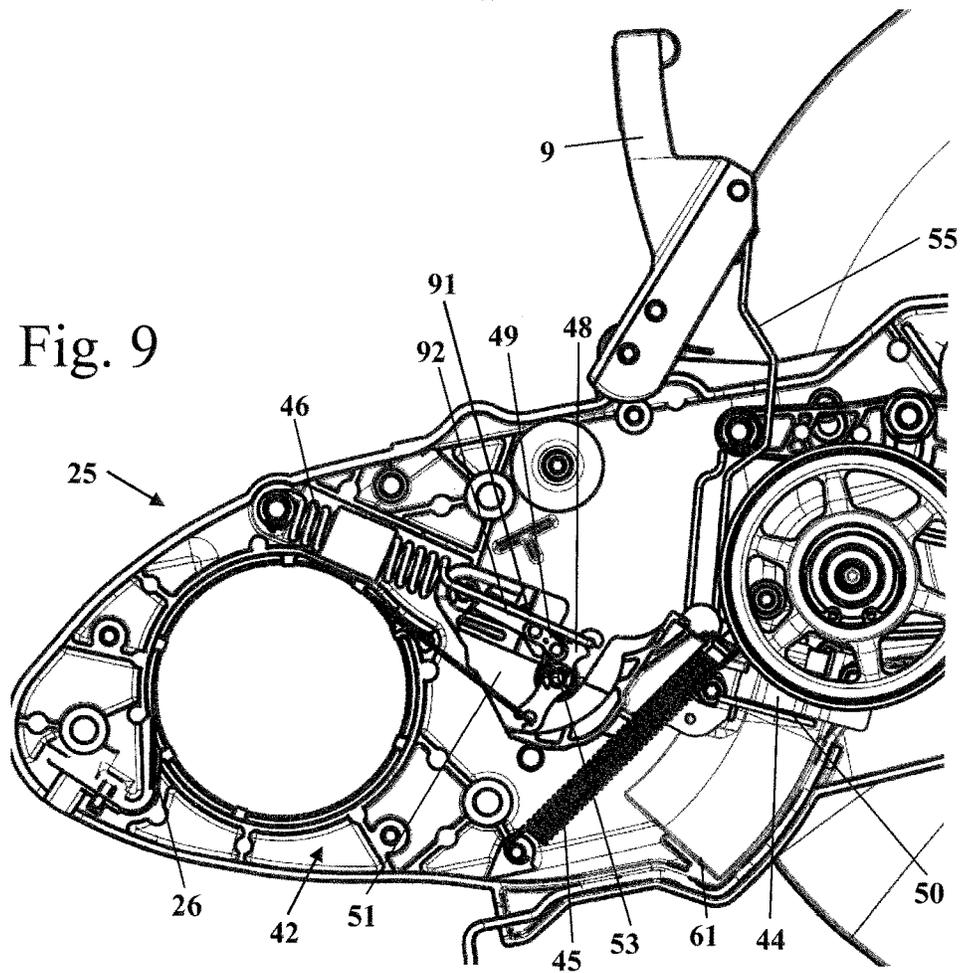


Fig. 10

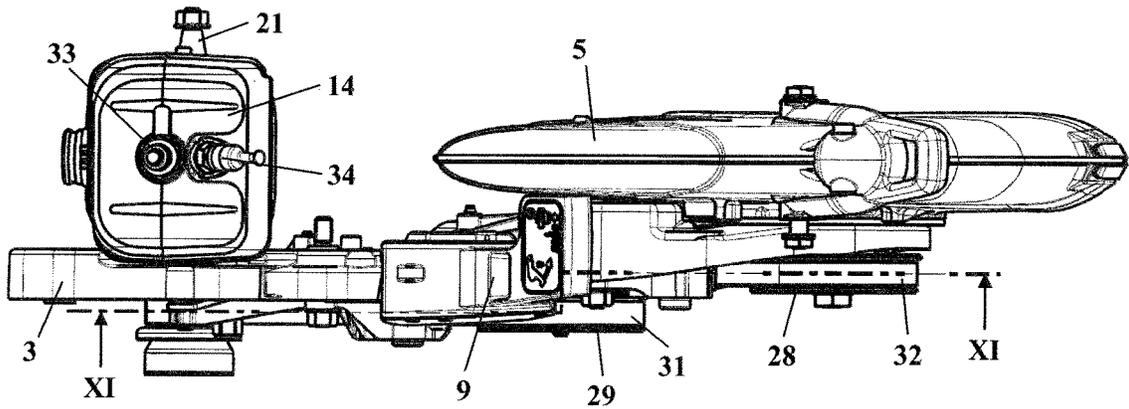
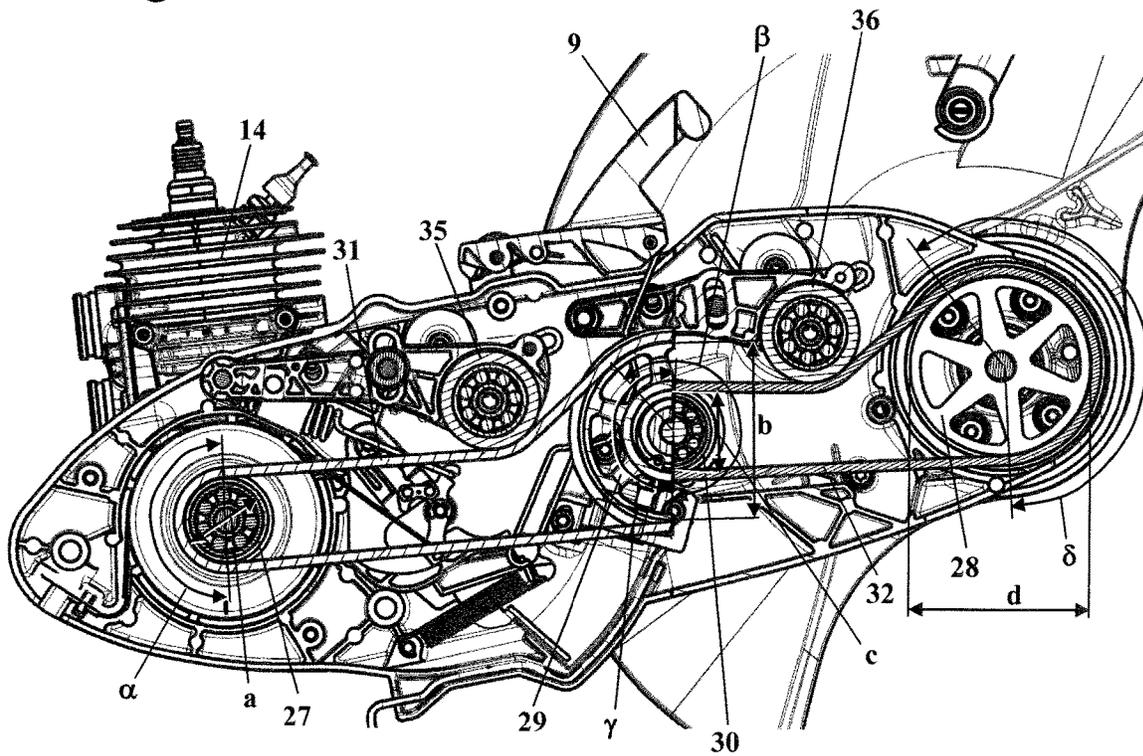
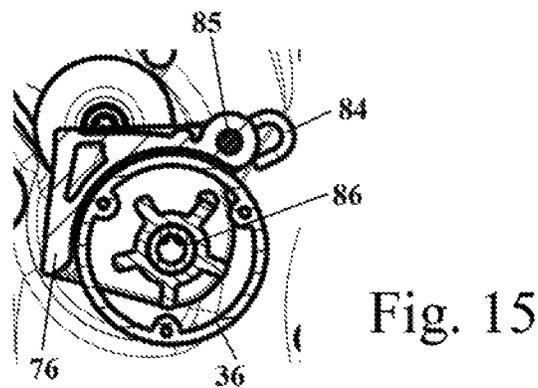
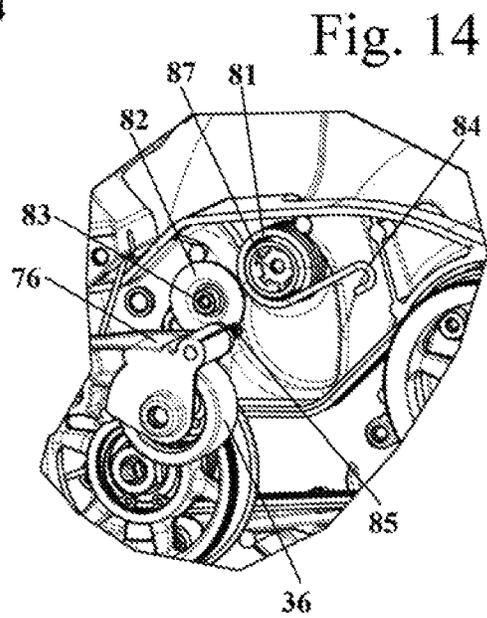
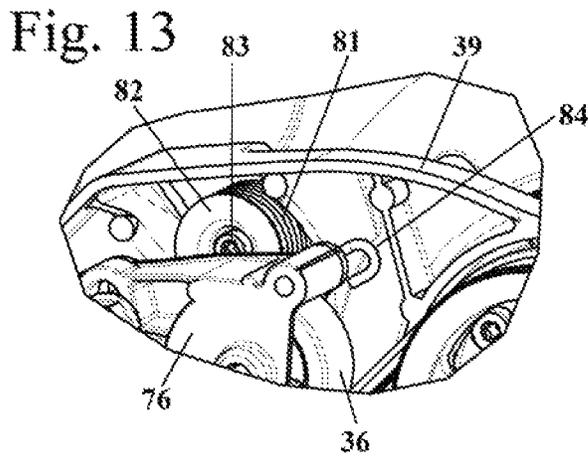
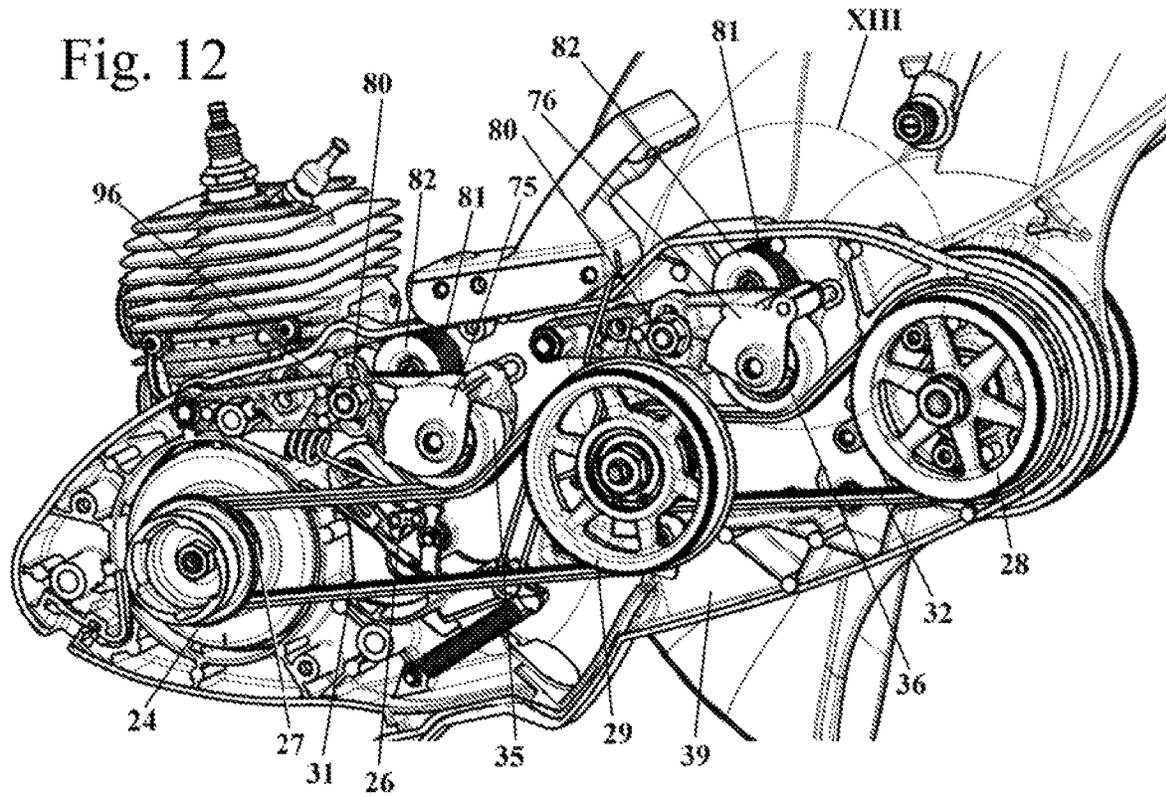


Fig. 11





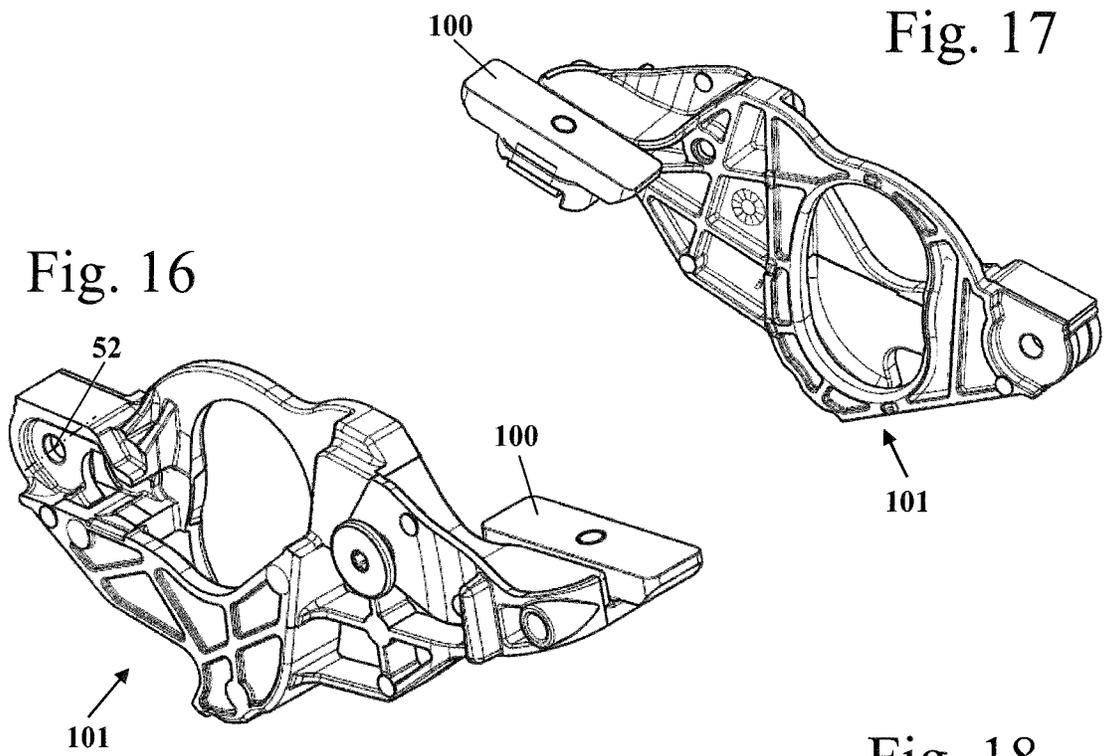


Fig. 19

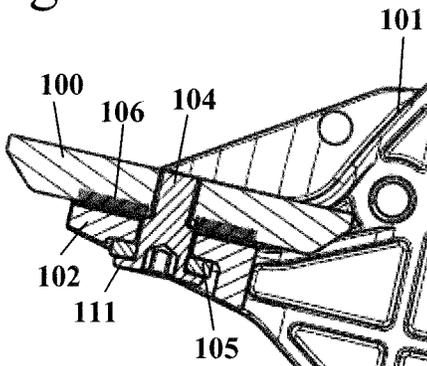
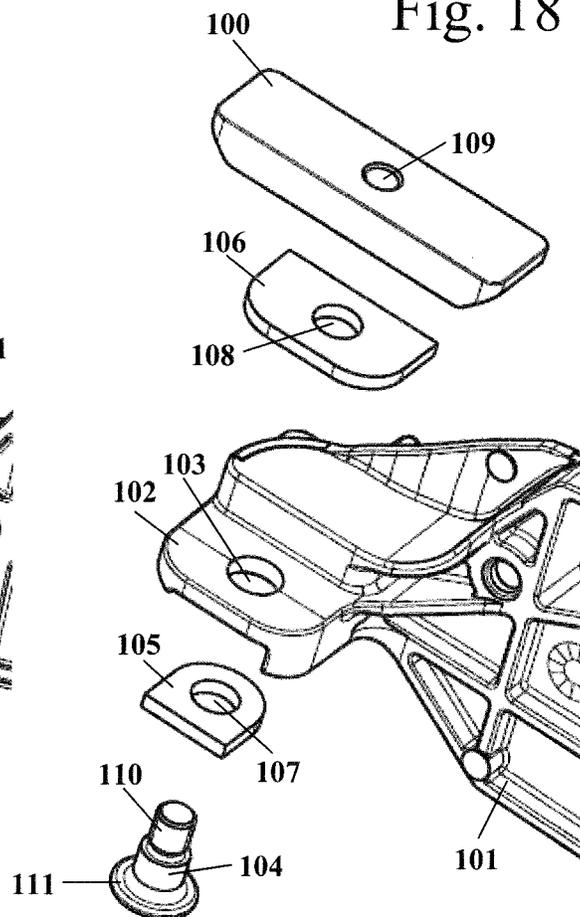


Fig. 18



HANDHELD WORK APPARATUS**CROSS REFERENCE TO RELATED APPLICATIONS**

This application is a continuation application of international patent application PCT/EP2015/001007, filed May 15, 2015, designating the United States and claiming priority from German application 10 2014 007 878.7, filed May 24, 2014, and the entire content of both applications is incorporated herein by reference.

BACKGROUND OF THE INVENTION

U.S. Pat. No. 6,039,037 has disclosed a cutting machine which is driven by internal combustion engine and the work tool of which is driven via a belt drive. Here, the diameter of the driving pulley is smaller for the two belts of the belt drive than the diameter of the driven pulley, with the result that the rotational speed of the work tool is lower than the rotational speed of the internal combustion engine.

A work apparatus is disclosed in U.S. Pat. No. 8,469,167. The work apparatus includes a brake unit which acts on the clutch drum. The brake unit is held in the release position during operation by the centrifugal weights of the centrifugal clutch. The brake unit can brake the work tool only when the coupling rotational speed is undershot.

U.S. Pat. No. 6,235,831 has disclosed a motorized cutting machine which is equipped with a dust collecting apparatus. The cut-off wheel of the cutting machine is driven via a two-stage belt drive. The first drive belt also drives an impeller wheel of the dust collecting apparatus. Redirection rolls are provided for guiding the drive belt.

United States patent application publication 2015/0258658 has disclosed a cut-off machine which has a brake unit with a belt brake.

EP 0 042 918 A1 has disclosed an electromechanical handheld power work tool which includes a band brake. The work tool is driven via a belt drive.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a work apparatus which makes braking of the work tool possible independently of the rotational speed of the work tool.

It is provided that the brake unit acts on the belt drive of the work apparatus. Here, the brake unit can act on the belt drive directly or indirectly, for example via a clutch drum. The belt drive is coupled to the work tool independently of the rotational speed of the work tool, with the result that braking of the work tool is possible via the belt drive at every rotational speed. In particular at high rotational speeds and if the work tool is a work tool with a great moment of inertia, for example a cut-off wheel, high forces are required to brake the work tool. In order to reduce the required forces, it is provided that the work apparatus has at least one first drive belt of a first drive stage and a second drive belt of a second drive stage. The first and the second drive stage in each case bring about a reduction in the rotational speed. Accordingly, the rotational speed of the driven pulley of each drive belt is lower than the rotational speed of the driving pulley of the drive belt. A sufficiently large rotational speed reduction with an overall compact configuration can be achieved by way of the at least two-stage configuration of the belt drive. The reduction in the rotational speed of the work tool brings about a reduction in the inertia forces on the work tool, with the result that braking of the work tool via

the belt drive is made possible. In order to achieve a reliable transmission of the braking force to the work tool, it is provided that at least one redirection roll bears against at least one drive belt. The tension in the drive belt is maintained via the redirection roll and lifting up of the drive belt from the pulley is avoided. As a result, the transmission of a sufficiently great braking moment to the work tool can be ensured. Here, the redirection roll advantageously enlarges the wraparound angle on at least one pulley, over which the at least one drive belt is guided. As a result, a rapid standstill of the work tool can be achieved by way of the brake unit.

At least one redirection roll bears against the drive belt, via which the highest drive moment is transmitted during operation. This is, in particular, the second drive belt which drives the second pulley which is connected fixedly to the work tool so as to rotate with it. As a result of the reduction in the rotational speed in every drive stage, the torque to be transmitted via the respective drive belt increases accordingly. In particular in the case of drive belts which transmit a high drive moment, lifting up of the drive belt from the pulley can be avoided in a simple way via the redirection roll.

A redirection roll advantageously bears against every drive belt. A compact construction of the work apparatus is made possible by way of the application of the belt tension via redirection rolls. The spacing of the rotational axis of the pulleys from one another can be fixed structurally and does not have to be variable in order to set the belt tension. Each redirection roll is advantageously arranged in such a way that an increase in the wraparound angle of the pulleys results.

The redirection rolls are advantageously arranged in such a way that, in the braking case, a redirection roll bears against the tight side of each drive belt which acts between the first and the second pulley. The redirection roll ensures that the brake force can be transmitted via the tight side in the braking case and prevents lifting up of the tight side from the pulley. As a result, the brake unit can be arranged in such a way that it acts on the driving, first pulley. The brake unit does not have to be arranged on the pulley, to which the work tool is connected, but rather can be arranged at a spacing from the work tool. This results in a simple construction. The tight side in the braking case is that side of each drive belt, via which the brake force is transmitted from the first pulley to the second pulley during the braking operation.

The redirection roll is advantageously held in a stationary manner during operation of the work apparatus. This ensures that the redirection roll cannot be pressed away during braking. The redirection roll is advantageously held in a stationary manner via a releasable fixation arrangement. When the fixation arrangement is released, the redirection roll is advantageously mounted in a pivotable and sprung manner. By virtue of the fact that the redirection roll is held in a stationary manner during operation, the spring can be configured in such a way that the desired belt tension results when the fixation arrangement is released. Therefore, the drive belt can be tensioned in a simple way by way of a release and, after the spring force has acted on the redirection roll and has tensioned the belt, renewed fixing of the fixation arrangement. The belt tension can be set without consideration of the forces which prevail on the redirection roll during the braking operation, since the redirection roll is held in a stationary manner in the braking case.

Each pulley of the belt drive is advantageously wrapped around by a drive belt of the belt drive over a wraparound angle of more than approximately 170°. In particular, each

pulley of the belt drive is wrapped around by a drive belt of the belt drive over a wraparound angle of more than approximately 180°. This results in the high forces which can be transmitted, in particular in the braking case, with the result that the work tool can be braked. At least one pulley is

advantageously wrapped around by a drive belt of the belt drive over a wraparound angle of more than 220°.

A simple construction results if the brake unit acts on the first pulley. As a result, the brake unit can be arranged at a spacing from the work tool, for example on the output side of a centrifugal clutch of the work apparatus.

In order to achieve a comparatively large reduction in the rotational speed of the work tool with respect to the drive motor and, as a result, comparatively low inertia forces which act on the work tool, the belt drive is of at least two-stage construction. The belt drive includes a first drive belt and a second drive belt, the first drive belt being guided over the first pulley and a third pulley, the third pulley being connected fixedly to a fourth pulley so as to rotate with it, and the second drive belt being guided over the fourth pulley. Here, the diameter of the fourth pulley is advantageously smaller than the diameter of the third pulley. One or more further drive belts can also be provided. On account of the redirection roll, the wraparound angle at every pulley can be kept comparatively great despite the different diameters of the pulleys. Here, the at least one redirection roll advantageously acts on the outer side of a drive belt and presses the drive belt inward in the direction of the other side of the belt, with the result that the wraparound angles on the drive pulleys are increased on account of the redirection of the drive belt on the redirection roll. The first pulley is preferably driven directly by the drive motor during operation. Accordingly, no further drive belt is arranged between the drive motor and the first pulley. Further elements, such as a clutch for example, can be arranged between the first pulley and the drive motor, however.

A simple construction of the brake unit results if the brake unit includes a brake band which acts on a brake drum, the brake drum being connected fixedly to the first pulley so as to rotate with it. In one particularly advantageous embodiment, the brake drum is the clutch drum of a centrifugal clutch of the work apparatus.

The brake unit advantageously has a brake position and a release position. The brake unit is advantageously held in the release position by a holding arrangement and is prestressed in the direction of the brake position by a triggering spring. Rapid triggering of the brake unit with low triggering forces is made possible by way of the prestress of the brake unit. The work apparatus advantageously has an actuating element, via which the brake unit can be adjusted out of the brake position into the release position. The actuating element can advantageously be actuated by the operator and can be, for example, an actuating lever or the like. During the adjustment of the brake unit out of the brake position into the release position, the triggering spring of the brake unit is advantageously stressed.

A simple construction results if the holding arrangement includes an electromagnet. This firstly ensures secure fixing of the brake unit in the release position. Secondly, the triggering of the brake unit can take place electronically. The work apparatus advantageously has a control unit and a sensor, the control unit causing a release of the holding arrangement if at least one triggering criterion which is determined by the sensor is present. The sensor is preferably a rotational speed sensor which determines the angular velocity of a movement of the work apparatus about an axis which is parallel to the rotational axis of the work tool. One

triggering criterion is advantageously the exceeding of a predefined angular velocity about the axis. If the work apparatus moves in an impermissible manner, the movement can be detected via the rotational speed sensor and the brake unit can be triggered. In addition to the triggering criterion, further triggering criteria can be used.

The brake unit is advantageously triggered in a manner which is dependent on a rotational speed threshold, in particular if a rotational speed threshold is undershot.

It is advantageously provided that the rotational speed of the second pulley is at most 60% of the rotational speed of the first pulley. The work apparatus is preferably a cut-off machine and the work tool is a cut-off wheel. The rotational speed of the cut-off wheel is, in particular, less than approximately 4000 revolutions per minute. The rotational speed of the cut-off wheel is advantageously less than approximately 3000 revolutions per minute. This results in a comparatively low moment of inertia of the cut-off wheel during operation, with the result that a sufficiently great braking force can be transmitted to the cut-off wheel via the belt drive.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with reference to the drawings wherein:

FIG. 1 shows a side view of a cut-off machine,

FIG. 2 is a diagrammatic sectional illustration of the cut-off machine from FIG. 1;

FIG. 3 shows a side view of the cantilever of the cut-off machine from FIG. 1 with a removed cover and with a drive motor arranged thereon and with a protective cover arranged thereon;

FIG. 4 and FIG. 5 show a detail from FIG. 3 which shows the belt drive;

FIG. 6 shows a side view of the brake unit on the cantilever in the brake position;

FIG. 7 shows a side view of the brake unit in the brake position without the cantilever;

FIG. 8 shows a detail from FIG. 7 with a partially sectioned triggering lever;

FIG. 9 shows the arrangement from FIG. 8 in the release position;

FIG. 10 shows a plan view of the arrangement of FIG. 3;

FIG. 11 shows a section along the line XI-XI of FIG. 10;

FIG. 12 is a perspective illustration of the arrangement from FIG. 3;

FIG. 13 shows the detail XIII of FIG. 12 in an enlarged illustration;

FIG. 14 shows the arrangement from FIG. 13 in an exploded illustration;

FIG. 15 shows a section through the redirection roll from FIG. 13;

FIGS. 16 and 17 are perspective illustrations of an embodiment of a triggering lever of a cut-off machine;

FIG. 18 is an exploded illustration of the triggering lever in the region of the retaining plate; and,

FIG. 19 shows a sectional illustration through the region of the retaining plate of the triggering lever.

DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

FIG. 1 shows a cut-off machine 1 as an example of an embodiment for a handheld work apparatus. The cut-off machine 1 has a housing 2, on which a cantilever 3 is fixed. A work tool 4, namely a cut-off wheel, is mounted rotatably at the free end of the cantilever 3. During operation, the

work tool 4 is driven so as to rotate in a rotational direction 10. The work tool 4 is covered over part of its circumference by a protective cover 5 which, in the embodiment, is configured in one piece with a housing part 39 (FIG. 3) of the cantilever 3. The protective cover 5 and the housing part 39 of the cantilever 3 can, for example, be made of metal and can be manufactured in a casting process. The cantilever 3 includes a cover 88 which closes the housing part 39. An actuating element 9 is arranged on the cantilever 3. The actuating element 9 is configured as an actuating lever in the embodiment and serves to actuate a brake unit which will be described in greater detail in the following text.

A handle 6 is arranged on the housing 2. The handle 6 is configured as a rear handle in the embodiment and is arranged on that side of the housing 2 which faces away from the work tool 4. The cantilever 3 protrudes forward on that side of the housing 2 which faces away from the handle 6. A throttle lever 11 and a throttle lever lock 12 are mounted pivotably on the handle 6. Moreover, a bale handle 7 is fixed on the housing 2. The bale handle 7 engages over the housing 2 on that side of the housing 2 which faces the work tool 4. The cut-off machine 1 has a starter arrangement 8 for a drive motor 14 (FIG. 2). A starter handle 13 which protrudes out of the housing 2 serves to actuate the starter arrangement 8.

FIG. 2 shows the construction of the drive of the cut-off machine 1 in greater detail. The drive motor 14 is configured as an internal combustion engine and has a cylinder 16, in which a combustion chamber 19 is formed. The drive motor 14 is configured as a single-cylinder engine. The combustion chamber 19 is delimited by a piston 18 which, via a connecting rod 20, drives a crankshaft 21 in a rotating manner. The crankshaft 21 is mounted in a crankcase 17 such that it can be rotated about a rotational axis 22. A flywheel 15 is fixed on the crankshaft 21. The flywheel 15 can be configured as an impeller wheel and can serve to deliver cooling air. A centrifugal clutch 23 is arranged on that side of the drive motor 14 which faces away from the flywheel 15. The centrifugal clutch 23 includes a clutch drum which serves as a brake drum 24 for a brake unit 25. A brake band 26 is arranged on the outer circumference of the brake drum 24. A first pulley 27 of a belt drive 70 (FIG. 3) is connected fixedly to the brake drum 24 so as to rotate with it. A first drive belt 31 is held on the first pulley 27. The starter arrangement 8 is connected fixedly to the crankshaft 21 so as to rotate with it and is arranged on that side of the first pulley 27 which faces away from the centrifugal clutch 23. In the embodiment, the drive motor 14 is a two-stroke engine. However, the drive motor 14 can also be a four-stroke engine.

FIG. 3 shows the construction of the belt drive 70 in detail. The belt drive 70 includes the first pulley 27 and a second pulley 28. The second pulley 28 is connected fixedly to the work tool 4 so as to rotate with it and is mounted such that it can be rotated about a rotational axis 74. The rotational axis 74 is the rotational axis of the work tool 4. The first drive belt 31 is guided over the first pulley 27 and the third pulley 29. Together with the first pulley 27 and the third pulley 29, the first drive belt 31 forms a first drive stage. A fourth pulley 30 (shown diagrammatically in FIG. 3) is connected fixedly to the third pulley 29 so as to rotate with it. A second drive belt 32 is guided over the fourth pulley 30 and the second pulley 28. Together with the fourth pulley 30 and the second pulley 28, the second drive belt 32 forms a second drive stage. A first redirection roll 35 bears against the first drive belt 31. The position of the first redirection roll 35 can be fixed via a fixation arrangement

37. A redirection roll 36 bears against the second drive belt 32, the position of which redirection roll 36 can likewise be fixed via a fixation arrangement 37. As FIG. 3 also shows, an engagement contour 38 for the starter arrangement 8 is connected fixedly to the brake drum 24 so as to rotate with it. A spark plug 33 and a decompression valve 34 are arranged on the cylinder 16. As FIG. 3 also shows, the cut-off machine 1 has a rotational speed sensor 40 which is connected to a control unit 57. An electromagnet 44 which will be described in greater detail in the following text is also connected to the control unit 57.

FIG. 4 shows the drive belt 70 in the drive case. The brake drum 24 is driven by the drive motor 14 in the direction of the arrow 71. The drive force is transferred to the third pulley 29 via a tight side 62 of the first drive belt 31. The other side (shown at the top in FIG. 4) of the drive belt 31 is the slack side 63 in the drive case. The redirection roll 35 bears against the slack side 63 in the drive case. The second drive belt 32 has a tight side 64, by which the drive force is transmitted from the fourth pulley 30 to the second pulley 28. The other side (likewise shown at the top in FIG. 4) of the second drive belt 32 is the slack side 65, against which the redirection roll 36 bears.

As FIG. 4 shows, the first redirection roll 35 is mounted on the housing part 39 such that it can be pivoted about a pivot axis 77 on a pivot lever 75. The pivot lever 75 has a groove 79, through which a bolt 96 protrudes, onto which a nut 80 is screwed. Together with the bolt 96, the nut 80 forms the fixation arrangement 37 (FIG. 3).

The second redirection roll 36 is mounted on a corresponding pivot lever 76 which is mounted on the housing part 39 such that it can be pivoted about a pivot axis 78. The pivot lever 76 likewise has a groove 79, through which a bolt 96 protrudes, onto which a nut 80 is screwed, and, together with the latter, forms the fixation arrangement 37 (FIG. 3) of the redirection roll 36.

FIG. 5 shows the arrangement in the braking case. The brake force which is applied by the brake band 26 (FIG. 3) acts on the brake drum 24 in the direction of the arrow 72. The tight side 62 of the drive case is the slack side 67 in the braking case. The slack side 63 in the drive case is the tight side 66 in the braking case, against which tight side 66 the redirection roll 35 bears. Accordingly, the tight side 64 of the second drive belt 32 is the slack side 69 in the braking case, and the slack side 65 in the drive case is the tight side 68 in the braking case. The redirection roll 36 bears against the tight side 68 in the braking case. The inertial force of the work tool 4 acts in the direction of the arrow 73 on the second pulley 28. The arrow 73 points in the rotational direction 10 of the work tool 4 (FIG. 1).

FIGS. 6 to 9 show the brake unit 25 in detail. FIGS. 6 to 8 show the brake unit 25 in its brake position 41. In the position, the brake band 26 (FIG. 7) is pulled fixedly around the outer circumference of the brake drum 24 and, as a result, brakes the brake drum 24 and the belt drive 70. The brake unit 25 has a lever arrangement 47 which includes a lever 48, a triggering lever 51 and a toggle lever 91. The toggle lever 91 has a first articulated lever 49 and a second articulated lever 92. As FIG. 8 shows, the lever 48 is mounted on the first housing part 39 about a pivot axis 53. The brake band 26 is held at a first end 89 of the lever 48. A brake spring 46 which prestresses the brake unit 25 in the direction of the brake position 41 acts at a second end 90 of the lever 48. The triggering lever 51 is held on the housing part 39 (FIG. 6) such that it can be pivoted about a pivot axis 52 which is shown in FIG. 7. As FIG. 8 shows, the first articulated lever 49 is mounted on the second articulated

lever 92 such that it can be pivoted about a pivot axis 54. The second articulated lever 92 is held with play on the triggering lever 51 and can be pivoted slightly about the pivot axis 52 of the triggering lever 51 for tolerance compensation. Here, the second articulated lever 92 is held between actuating contours 93 and 95 of the triggering lever 51. The second end of the first articulated lever 49 is fixed on the lever 48 such that it can be pivoted about a pivot axis 60. The triggering lever 51 is prestressed in the direction of the brake position 41 via a triggering spring 45 which is shown in FIG. 8. The triggering lever 51 has a retaining plate 50 which interacts with an electromagnet 44 in the release position 42 of the brake unit 25. Together with the retaining plate 50, the electromagnet 44 forms a holding arrangement 43 which holds the brake unit 25 in its release position 42 (FIG. 9). Moreover, a coupling element 55 (shown in FIG. 6) acts on the triggering lever 51. The coupling element 55 is connected to the actuating element 9.

As FIG. 7 shows, the coupling element 55 includes a longitudinal guide 56. The triggering lever 51 is guided with a bearing element 59 in the longitudinal guide 56. If the actuating element 9 is pivoted out of the position which is shown in FIG. 7 in the direction of the arrow 94 into the position which is shown in FIG. 9, the coupling element 55 drives the triggering lever 51 on the bearing element 59 and pivots the lever about the pivot axis 52 (FIG. 7). Here, the triggering spring 45 and the brake spring 46 are stressed. The retaining plate 50 passes onto the electromagnet 44. The electromagnet 44 is energized during operation of the cut-off machine 1 and holds the magnetic retaining plate 50 as a result. As a result, the brake unit 25 is held in its release position 42 which is shown in FIG. 9. The energy for energizing the electromagnet 44 is generated during operation on account of the rotation of the crankshaft 21. If the rotational speed of the drive motor 14 and therefore also of the crankshaft 21 falls below a structurally predefined rotational speed, the energy of the electromagnet 44 is no longer sufficient to hold the retaining plate 50. The triggering lever 51 is pivoted by the triggering spring 45, and the brake unit 25 is moved into its brake position 41. At a standstill of the drive motor 14, the brake unit 25 is in its brake position 41 as a result. It can be provided to provide further energy store devices which supply the electromagnet 44 with energy. As a result, the rotational speed, upon the undershooting of which the brake unit 25 is adjusted into its brake position 41, can be shifted toward low rotational speeds. The additional energy store devices can be, for example, accumulators, capacitors, a mechanical flywheel mass or the like.

As FIGS. 8 and 9 show, the triggering lever 51 pivots about the pivot axis 52 during pivoting out of the brake position 41 (FIG. 8) into the release position 42 (FIG. 9). Here, the triggering lever 51 drives the second articulated lever 92 via the actuating contour 93. Here, the dead center of the toggle lever 91 is overcome. During the pivoting of the lever 48, the brake spring 46 is stressed and the brake band 26 is released.

In order to trigger the brake unit, the power supply to the electromagnet 44 is interrupted or the energy which is provided to the electromagnet 44 drops on account of a decreasing rotational speed below a structurally predefined threshold. As a result, the retaining plate 50 is no longer held on the electromagnet 44. The triggering lever 51 is pivoted on account of the prestress of the triggering spring 45. The triggering lever 51 drives the second articulated lever 92 via the actuating contour 95 and, as a result, adjusts the toggle lever 91 via its dead center position into a position, in which the brake spring 46 acts on the lever 48. On account of the

force of the brake spring 46, the lever 48 pivots and in the process stresses the brake band 26. As a result, the arrangement can be held in the release position 42 by way of low force, and only a low force is required on the triggering lever 51 in order to trigger the braking operation. The triggering spring 45 merely has to pivot the triggering lever 51 until the dead center of the toggle lever 91 is overcome. For this purpose, only a low force and a low spring travel are required. A leg spring can also be provided, for example, as triggering spring 45. The braking force itself is applied by the prestressed brake spring 46.

As FIGS. 8 and 9 also show, a stop 61 for the triggering lever 51 is configured on the housing part 39. The stop 61 is advantageously configured from an elastic material and serves to cushion the retaining plate 50 into the brake position 41 during adjustment of the brake unit 25. It can also be provided to provide a stop for the triggering lever 51 as an alternative. Here, the stop made from elastic material can be provided on the housing part 39 and/or on the triggering lever 51 or on the retaining plate 50.

On account of the decoupling of the position of the actuating element 9 from the position of the bearing element 59 via the longitudinal guide 56, the actuating element 9 can be pivoted back after pivoting in the direction of the arrow 94 in FIG. 7, that is, after adjusting the brake unit 25 from the release position 42 into the brake position 41. Here, the brake unit 25 is held in the brake position 41 which is shown in FIG. 9 by the holding arrangement 43.

It is provided during operation of the cut-off machine 1 that the operator adjusts the brake unit into the release position 42 before beginning work with the cut-off machine. As FIG. 7 shows, the electromagnet 44 is connected via a connecting line 58 to the control unit 57 which is also connected to the rotational speed sensor 40 according to FIG. 3. The rotational speed sensor 40 determines the angular velocity of a movement of the work apparatus about an axis which is parallel to the rotational axis 74 of the work tool 4. As soon as a predefined angular velocity about the axis is exceeded and is detected by the control unit 57 on the basis of the values which are supplied by the rotational speed sensor 40, the control unit 57 triggers the brake unit 25 by interrupting the power supply to the electromagnet 44. This brings about a release of the holding arrangement 43. When the holding arrangement 43 is released, the triggering spring 45 and the brake spring 46 adjust the brake unit 25 into the brake position 41 and brake the brake drum 24. The work tool 4 is braked via the drive belts 31 and 32. If the rotational speed of the drive motor 14 falls below a structurally predefined rotational speed threshold, the energy of the electromagnet 44 is no longer sufficient to hold the brake unit 25 in the release position 42, and the brake unit 25 is adjusted into its brake position 41.

The sectional illustration in FIG. 11 which shows the section shown in FIG. 10 through the belt drive 70 shows the diameters and wraparound angles on the pulleys 27 to 30. The first pulley 27 has a diameter (a) and is wrapped around by the first drive belt 31 over a wraparound angle α which is advantageously at least approximately 170° , in particular more than approximately 180° . In the embodiment, the wraparound angle α is approximately 180° . The third pulley 29 has a diameter (b) which is considerably greater than the diameter (a) of the first pulley 27. The third pulley 29 is wrapped around by the first drive belt 31 over a wraparound angle β which is advantageously more than approximately 170° , in particular more than approximately 180° . The wraparound angle β is preferably at least approximately 220° .

The fourth pulley **30** has a diameter (c) which is considerably smaller than the diameter (b) of the third pulley **29**. The diameter (b) can be, for example twice, preferably at least 2.5 times the diameter (c). The fourth pulley **30** is wrapped around by the second drive belt **32** over a wrap-around angle γ which is advantageously at least approximately 170° , in particular at least approximately 180° .

The second pulley **28** has a diameter (d) which can preferably correspond approximately to the diameter (b) of the third pulley **29**. The diameter (d) is considerably greater than the diameter (c) of the fourth pulley **30**. The diameter (d) can be, for example, at least twice, preferably at least 2.5 times the diameter (c). The second pulley **28** is wrapped around by the second drive belt **32** over a wraparound angle δ which is advantageously more than approximately 180° , in particular at least approximately 220° . The comparatively large wraparound angles γ and δ are achieved on account of the redirection rolls **35** and **36**. It is achieved on account of the different diameters of the pulleys **28** to **30** that the rotational speed of the second pulley **28** is considerably lower than the rotational speed of the first pulley **27**. The rotational speed of the second pulley **28** is advantageously at most approximately 60% of the rotational speed of the first pulley **27**. The rotational speed of the work tool **4**, namely of the cut-off wheel of the cut-off machine **1**, is advantageously less than approximately 4000 revolutions per minute, preferably less than approximately 3000 revolutions per minute. On account of the lower rotational speed of the second pulley **28**, the torque which is transmitted to the second pulley **29** is considerably greater than the torque which is transmitted from the first pulley **27** to the first drive belt **31**. A redirection roll **36** on the drive belt **32** is advantageous, in particular, on the second drive stage.

FIGS. **12** to **15** show the configuration and mounting of the redirection rolls **35** and **36** in detail. The two pivot levers **75** and **76** are advantageously of identical configurations. A spring **81** is mounted on the housing part **39** adjacently with respect to each redirection roll **35**, **36**. The spring **81** is configured in the embodiment as a torsion spring. The spring **81** is covered on its end side by a retaining plate **82** and is fixed axially as a result. As FIG. **13** shows, the retaining plate **82** is fixed on the housing part **39** by way of an attachment screw **83**. The spring **81** has one end **84** which acts on the pivot lever **76**. As FIG. **14** shows, a lug **85** is held on the pivot lever **76**, on which lug **85** the end **84** of the spring **81** acts. The spring **81** is held on a bearing support **87** of the housing part **39**. As FIG. **15** shows, the redirection roll **36** is mounted on the pivot lever **76** such that it can be rotated on a bearing pin **86**. The second end of the spring **81** is supported on the housing part **39**. The mounting of the redirection roll **35** on the pivot lever **75** is configured in a corresponding manner to the mounting of the redirection roll **36**.

In order to tension the drive belt **31** and **32**, the nuts **80** on the pivot levers **75** and **76** are released. As a result, in each case one spring **81** acts via a lug **85** on the pivot lever **75** and the pivot lever **76** which, as a result, is pressed with the predefined force against the drive belts **31** and **32**. Subsequently, the nuts **80** are fixed, with the result that the pivot lever **75** and **76** are held on the housing part **39** in a stationary manner. During the braking operation, the redirection rolls **35** and **36** bear against the tight side **66** and **68** of the drive belts **31**, **32**. By virtue of the fact that the redirection rolls are held on the housing part **39** in a stationary manner, sufficiently great forces can be transmitted to the work tool **4** via the belt drive **70**.

In the embodiment, the brake unit **25** acts on the first pulley **27**. However, it can also be provided that the brake unit **25** acts on the fourth pulley **30**. The fourth pulley **30** is also a driving pulley. The arrangement of a brake unit **25** on the fourth pulley **30** results in a simple construction, since the brake unit **25** does not have to be arranged on the driven pulley **28**, that is, not in the immediate spatial vicinity of the work tool **4**.

FIGS. **16** to **18** show one embodiment of a triggering lever **101** for the brake unit **25**. The construction of the triggering lever **101** corresponds substantially to that of the triggering lever **51**. The triggering lever **101** is mounted such that it can be pivoted about a pivot axis **52**. A retaining plate **100** is fixed on the triggering lever **101**. The retaining plate **100** can be moved slightly, in particular can be tilted, in order to compensate for tolerances with respect to the triggering lever **101**. This can ensure that the retaining plate **100** can bear flatly against the electromagnet **44**, as a result of which a sufficiently high holding force is ensured.

FIGS. **18** and **19** show the movable mounting of the retaining plate **100** in detail. As FIG. **18** shows, the triggering lever **101** has a fixation region **102**, on which the retaining plate **100** is fixed. An attachment opening **103** extends through the fixation region **102**, through which attachment opening **103** an attachment screw **104** protrudes. In the embodiment, the attachment screw **104** is screwed into the retaining plate **100**. To this end, the attachment screw **104** has a thread section **110** which is screwed into an attachment opening **109** of the retaining plate **100**. The attachment opening **109** is provided with an internal thread. A damping element **105** is arranged between the head **111** of the attachment screw **104** and the fixation region **102**. The damping element **105** has an attachment opening **107**, through which the attachment screw **104** protrudes. A further damping element **106** is arranged between the fixation region **102** and the retaining plate **100**. The further damping element **106** has an attachment opening **108**, through which the attachment screw **104** protrudes. The damping elements **105** and **106** can be made of an elastic material and are configured as flat plates in the embodiment.

FIG. **19** shows the construction in the assembled state. The damping element **105** is arranged between the head **111** of the attachment screw **104** and the fixation region **102**, and the retaining plate **100** is arranged on the opposite side of the fixation region **102**. The damping element **106** is arranged between the fixation region **102** and the retaining plate **100** and, in the embodiment, protrudes into a depression of the retaining plate **100**. Here, the arrangement is such that the retaining plate **100** can be moved slightly, in particular can be tilted about its longitudinal axis and its transverse axis, with respect to the fixation region **102** of the triggering lever **101**. As a result, tolerances between the retaining plate **100** and the electromagnet **44** can be compensated for, and the retaining plate **100** can bear flatly against the electromagnet **44**.

Other configurations for compensating for the tolerances between the retaining plate (**50**, **100**) and the electromagnet **44** can also be expedient.

It is understood that the foregoing description is that of the preferred embodiments of the invention and that various changes and modifications may be made thereto without departing from the spirit and scope of the invention as defined in the appended claims.

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What is claimed is:

1. A handheld work apparatus comprising:

a work tool;

a belt drive;

a drive motor configured to drive said work tool via said 5
belt drive;

said belt drive having a first pulley configured as a driving
pulley and a second pulley configured as a driven
pulley;

said second pulley being connected to said work tool in a 10
rotationally fixed manner;

said first pulley being configured to rotate at a first
rotational speed;

said second pulley being configured to rotate at a second 15
rotational speed;

said second rotational speed being less than said first
rotational speed;

a first drive belt configured to act between said first pulley
and said second pulley so as to transfer a drive torque
for a first drive stage;

a second drive belt configured to act between said first 20
pulley and said second pulley so as to transfer a drive
torque for a second drive stage;

said first drive stage and said second drive stage each
being configured to effect a rotational speed reduction; 25

said second drive belt being guided over said second
pulley;

said belt drive further having at least one redirection roll
configured to contact at least one of said first drive belt
and said second drive belt; 30

a brake unit configured to act on said belt drive; and,
said at least one redirection roll being configured to
contact at least one of said first drive belt and said
second drive belt transferring the higher drive torque.

2. The handheld work apparatus of claim **1**, wherein each 35
of said first drive belt and said second drive belt has at least
one of said at least one redirection roll in contact therewith.

3. The handheld work apparatus of claim **1**, wherein said
at least one redirection roll is held in a positionally fixed
manner during operation of the work apparatus.

4. The handheld work apparatus of claim **3** further com-
prising:

a housing;

a fixation arrangement having a fixed state and a released
state;

said fixation arrangement being configured to hold said at 45
least one redirection roll in a positionally fixed manner
when said fixation arrangement is in said fixed state;
and,

said at least one redirection roll being pivotably mounted 50
on said housing and being resiliently biased when said
fixation arrangement is in said released state.

5. The handheld work apparatus of claim **1**, wherein each
of said first pulley and said second pulley are configured to
be wrapped by one of said first drive belt and said second 55
drive belt with a wrap angle of at least 170°.

6. The handheld work apparatus of claim **5**, wherein said
second pulley is configured to be wrapped by one of said
first drive belt and said second drive belt with a wrap angle
of at least 220°. 60

7. The handheld work apparatus of claim **1**, wherein said
brake unit is configured to act on said first pulley.

8. The handheld work apparatus of claim **1**, wherein:

said belt drive further has a third pulley and a fourth 65
pulley;

said first drive belt is guided over said first pulley and said
third pulley;

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said third pulley is connected to said fourth pulley in a
rotationally fixed manner; and,

said second drive belt is guided over said fourth pulley.

9. The handheld work apparatus of claim **8**, wherein:

said fourth pulley has a diameter (c);

said third pulley has a diameter (b); and,

said diameter (c) is smaller than said diameter (b).

10. The handheld work apparatus of claim **1**, wherein said
drive motor is configured to drive said first pulley during
operation.

11. The handheld work apparatus of claim **1**, wherein said
brake unit includes a brake drum connected to said first
pulley in a rotationally fixed manner; and, said brake unit
further includes a brake band configured to act on said brake
drum.

12. The handheld work apparatus of claim **1** further
comprising:

a holding arrangement;

said brake unit having a braking position and a released
position;

said holding arrangement being configured to hold said
brake unit in said released position; and,

a triggering spring configured to pretension said brake
unit in the direction of said braking position.

13. The handheld work apparatus of claim **12** further
comprising:

an actuating element; and,

said brake unit being configured to be adjustable out of
said braking position into said released position via said
actuating element.

14. The handheld work apparatus of claim **1**, wherein said
second pulley is configured to rotate at a rotational speed of
at most 60% of a rotational speed of said first pulley.

15. The handheld work apparatus of claim **1**, wherein the
handheld work apparatus is a cut-off machine and said work
tool is a cutting disc.

16. The handheld work apparatus of claim **15**, wherein
said cutting disc is configured to rotate at less than 4000
revolutions per minute.

17. A handheld work apparatus comprising:

a work tool;

a belt drive;

a drive motor configured to drive said work tool via said
belt drive;

said belt drive having a first pulley configured as a driving
pulley and a second pulley configured as a driven
pulley;

said second pulley being connected to said work tool in a
rotationally fixed manner;

said first pulley being configured to rotate at a first
rotational speed;

said second pulley being configured to rotate at a second
rotational speed;

said second rotational speed being less than said first
rotational speed;

a first drive belt configured to act between said first pulley
and said second pulley so as to transfer a drive torque
for a first drive stage;

a second drive belt configured to act between said first
pulley and said second pulley so as to transfer a drive
torque for a second drive stage;

said first drive stage and said second drive stage each
being configured to effect a rotational speed reduction;

said second drive belt being guided over said second
pulley;

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said belt drive further having at least one redirection roll configured to contact at least one of said first drive belt and said second drive belt;

a brake unit configured to act on said belt drive;

said at least one redirection roll being configured to contact at least the one of said first drive belt and said second drive belt transferring the higher drive torque;

a holding arrangement;

said brake unit having a braking position and a released position;

said holding arrangement being configured to hold said brake unit in said released position; and,

said holding arrangement including an electromagnet.

18. A handheld work apparatus comprising:

a work tool;

a belt drive;

a drive motor configured to drive said work tool via said belt drive;

said belt drive having a first pulley configured as a driving pulley and a second pulley configured as a driven pulley;

said second pulley being connected to said work tool in a rotationally fixed manner;

said first pulley being configured to rotate at a first rotational speed;

said second pulley being configured to rotate at a second rotational speed;

said second rotational speed being less than said first rotational speed;

a first drive belt configured to act between said first pulley and said second pulley so as to transfer a drive torque for a first drive stage;

a second drive belt configured to act between said first pulley and said second pulley so as to transfer a drive torque for a second drive stage;

said first drive stage and said second drive stage each being configured to effect a rotational speed reduction;

said second drive belt being guided over said second pulley;

said belt drive further having at least one redirection roll configured to contact at least one of said first drive belt and said second drive belt;

a brake unit configured to act on said belt drive;

said at least one redirection roll being configured to contact at least the one of said first drive belt and said second drive belt transferring the higher drive torque;

a holding arrangement;

said brake unit having a braking position and a released position;

said holding arrangement being configured to hold said brake unit in said released position;

said holding arrangement including an electromagnet;

a control unit;

a sensor configured to determine a triggering criterium; and,

said control unit being configured to effect a releasing of said holding arrangement when a triggering criterium is determined.

19. The handheld work apparatus of claim **18**, wherein:

said work tool defines a work tool rotational axis;

said sensor is a rotational speed sensor configured to determine an angular speed of a movement of the handheld work apparatus about an axis parallel to said work tool rotational axis; and,

said control unit is configured to determine said triggering criterium when said angular speed exceeds a predetermined angular speed.

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20. A handheld work apparatus comprising:

a work tool;

a belt drive;

a drive motor configured to drive said work tool via said belt drive;

said belt drive having a first pulley configured as a driving pulley and a second pulley configured as a driven pulley;

said second pulley being connected to said work tool in a rotationally fixed manner;

said first pulley being configured to rotate at a first rotational speed;

said second pulley being configured to rotate at a second rotational speed;

said second rotational speed being less than said first rotational speed;

a first drive belt configured to act between said first pulley and said second pulley so as to transfer a drive torque for a first drive stage;

a second drive belt configured to act between said first pulley and said second pulley so as to transfer a drive torque for a second drive stage;

said first drive stage and said second drive stage each being configured to effect a rotational speed reduction;

said second drive belt being guided over said second pulley;

said belt drive further having at least one redirection roll configured to contact at least one of said first drive belt and said second drive belt;

a brake unit configured to act on said belt drive;

said at least one redirection roll being configured to contact at least the one of said first drive belt and said second drive belt transferring the higher drive torque;

a holding arrangement;

said brake unit having a braking position and a released position;

said holding arrangement being configured to hold said brake unit in said released position;

said holding arrangement including an electromagnet; and,

wherein said drive motor is an engine having a crankshaft; and, wherein energy to supply current to said electromagnet during operation of said handheld work apparatus is generated because of the rotation of said crankshaft; and, wherein said handheld work apparatus further comprises an energy store for supplying said electromagnet with energy.

21. The handheld work apparatus of claim **20**, wherein said energy store is one of the following: a battery, a capacitor or a mechanical flywheel mass.

22. The handheld work apparatus of claim **20**, wherein, because of said energy store which supplies energy to said electromagnet, the rotational speed, which when undershot causes said brake unit to move into said braking position, is shifted toward lower rotational speeds.

23. The handheld work apparatus of claim **20**, wherein, because of said energy store which supplies energy to said electromagnet, the rotational speed, which when undershot causes said brake unit to move into said braking position, is shifted toward lower rotational speeds; and, said lower rotational speeds are lower than a structurally predefined rotational speed whereat the energy of said electromagnet is no longer sufficient to hold said holding plate when the energy for supplying current to said electromagnet is generated because of the rotation of said crankshaft.

24. The handheld work apparatus of claim **20**, wherein said brake unit is shifted into said braking position thereof

when the energy of said electromagnet is no longer sufficient to hold the brake unit in said released position.

25. The handheld work apparatus of claim 20, wherein said brake unit includes a release spring; and, said brake unit is pretensioned toward said braking position by said release 5 spring.

26. The handheld work apparatus of claim 20, wherein the energy to supply current to said electromagnet during operation of the work apparatus is generated because of the rotation of said crankshaft of said engine; and, wherein said 10 handheld work apparatus further comprises an additional energy store to supply said electromagnet with energy.

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